Nelson Forest Region	**Effect of Calcareous Soil Deposits on Underlying Forest Floor pH in the Rocky Mountain Trench** **by** **Karen Hall and Mike Curran**	
	Extension Note 045	

INTRODUCTION

In many parts of the Nelson Forest Region in southeastern British Columbia, the spread of Armillaria root rot in forested areas has increased to the point that its potential negative effects on future site productivity is a significant concern for forest managers. For example, in the Invermere Forest District, *Amillaria ostoyae* is considered to be affecting forest productivity on 50 000 ha (22% of the operational landbase). Stump removal (pushover harvesting) is a recommended treatment for controlling root rot provided the soils are not too sensitive (Norris et al 1998). However, stump removal activities are nevertheless often associated with detrimental soil disturbance; while not all disturbance from stump removal is considered detrimental, disturbance levels can be significant where stump removal activities occur on sensitive soils.

- ***On sites with calcareous soils and where stump removal (pushover harvesting) is used to control Armillaria root rot, the resulting subsoil deposits may lead to a dramatic rise in forest floor pH.***
- ***On calcareous soils, there is concern that the negative effects of increased soil disturbance caused by pushover harvesting may cancel out any expected benefit of stump removal in controlling the spread of Armillaria.***

A serious concern in the Rocky Mountain Trench and Rocky Mountains are calcareous soils (i.e. high pH soils), which are considered unfavourable for tree growth (Kishchuk et al, 1999). Pushover harvesting on calcareous soils can result in the soil becoming calcareous at the surface; up to 100% of the soil surface can become calcareous locally, and up to 29% of the soil over an entire cutblock (Quesnel and Curran 1999). These deposits represent lime on the soil surface that acts as a buffer which retards acidification of these deposits, and probably negatively affects the underlying soil through leaching.

On calcareous soils, there is concern that the expected negative effects of increased soil disturbance caused by pushover harvesting may cancel out any expected benefit of stump removal in controlling the spread of Armillaria. Whitetail Brook is one of several research installations where this trade-off is being investigated (Sacenieks and Pinnell 1998); however, at least five years must be allowed to pass before an accurate picture of changes to the soil can be obtained. In the meantime, a lab experiment, summarized in this Extension Note, has been conducted in an attempt to predict what will happen to the surface soil layers during the first five years of natural leaching.

OBJECTIVE

The objective of the lab experiment was to mimic spring thaw leaching conditions and thereby predict the chemical effects of:

- calcareous deposits on underlying forest floor deposits, and

- the longevity of these effects.

METHODS

Samples of subsoils and the forest floor were collected in the Rocky Mountains, in the vicinity of the pushover harvesting research site at Whitetail Brook, near Kilometre 10 on the Whiteswan Forest Service Road (Sacenieks and Pinnell 1998).

Two types of calcareous subsoil and two deposit depths were tested over an underlying forest floor layer, along with a control of forest floor alone (Table 1).

Table 1. Design of the lab experiment.

Years after harvesting	Type of soil deposit	Depth of deposit (cm)
1	Strong calcareous	2
	Strong calcareous	8
	Extreme calcareous	2
	Extreme calcareous	8
	No deposit	n.a.
5	Strong calcareous	2
	Strong calcareous	8
	Extreme calcareous	2
	Extreme calcareous	8
	No deposit	n.a.

At the Regional office lab, three replicates of each treatment were constructed in columns of PVC pipe, with 2 cm of forest floor underlying the deposit. The columns were moistened and then frozen to mimic fall freeze-up. Snow was added to each column and allowed to thaw (protected from fresh air) to mimic spring thaw leaching conditions (with a snow water equivalent of 15 cm). Over a two-week period, columns were allowed to thaw and leach to simulate either one year or five years of leaching.

The pH was measured for the leachate, soil, and the forest floor. All samples were sent to the BC Ministry of Forests (BCMOF) research lab for further analysis. Future analysis will include statistical analysis of this data and the nutrient data from the BCMOF lab.

RESULTS

The results from the replicates of each treatment were almost identical, so no error bars appear on the graphs that show the average values. Figure 1 shows that, after an initial slight drop in pH, the pH of the mineral soils did not change from Year One to Year Five. The extreme calcareous deposits (EX Deposits) were initially pH of 8.9, but dropped to 8.55 at a depth of 2 cm and to 8.70 at a depth of 8 cm. The strong calcareous deposits (ST Deposits) were initially pH of 8.1 before leaching, and

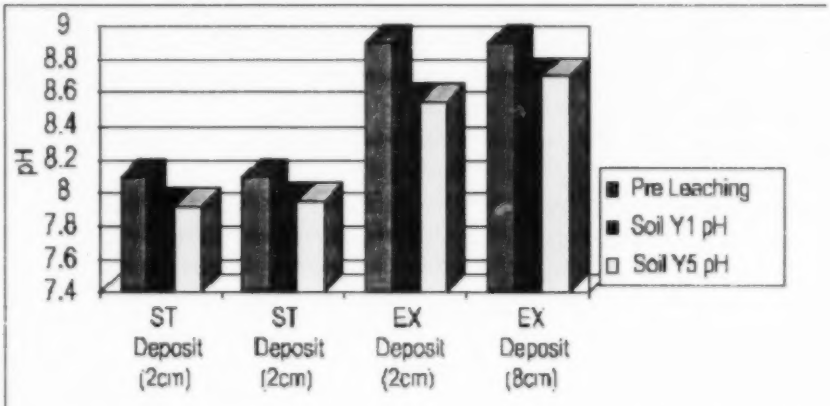

Figure 1. Mineral soil pH after one year and five years of leaching. The leachate showed a continual increase in pH over time in relation to both the strength of the calcareous subsoil and the depth of material (Figure 2).

dropped to 7.92 and 7.95 at the respective depths of 2 cm and 8 cm. All samples remained the same pH from Year One to Year Five.

The leachate derived from the forest floor show pH levels of 6.7 to 6.83 from Years One to Five (Figure 2). The extreme calcareous subsoils leached through forest floor had a leachate pH of 7.97-8.13 between Year One and Year Five.

Forest floor showed similar results (Figure 3), with resulting pH increasing with the strength of calcareous material and the time of leaching. The forest floor below the strong calcareous deposit of 2 cm showed an increase of pH from 6.85-7.02 over the equivalent of five years. This increase is slightly higher than the 8-cm deposit of strong calcareous material over forest floor.

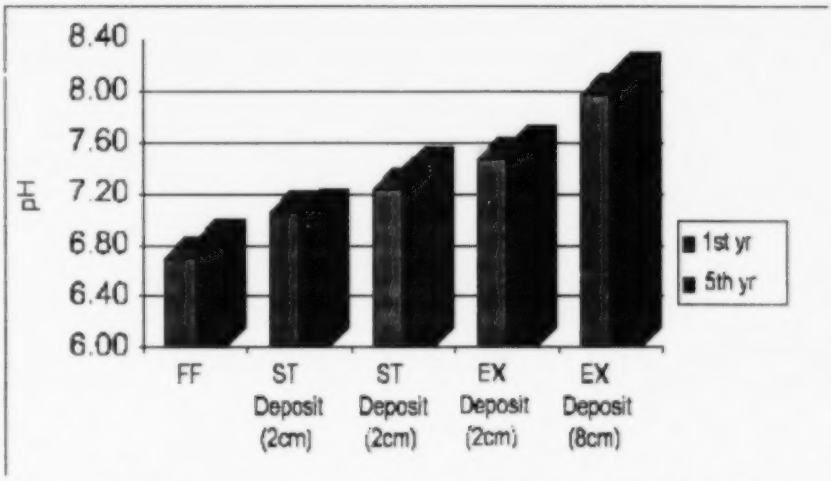

Figure 2. pH of leachate derived from treatments (mineral soils + forest floor), Year One and Year Five post-harvest.

Figure 3 shows that the extreme deposits have a large effect, increasing the pH from 6.93 (forest floor with no deposit) to 7.52 after five years of leaching. (Because pH is a logarithmic scale, this is approximately a five-fold decrease in acidity [H ion activity].) These results demonstrate the potential for subsoil deposits to continue to increase pH of the underlying soil over time through further weathering of the free lime in these calcareous soils.

DISCUSSION

The preliminary results indicate that a dramatic rise in forest floor pH can occur under calcareous soil deposits. Given the shallow depth of the deposits studied, the rise in pH is cause for concern and warrants further study.

The results of nutrient and statistical studies will accompany this information in the future. It is hoped that the results of these studies will lead to a greater understanding of not only how the calcareous

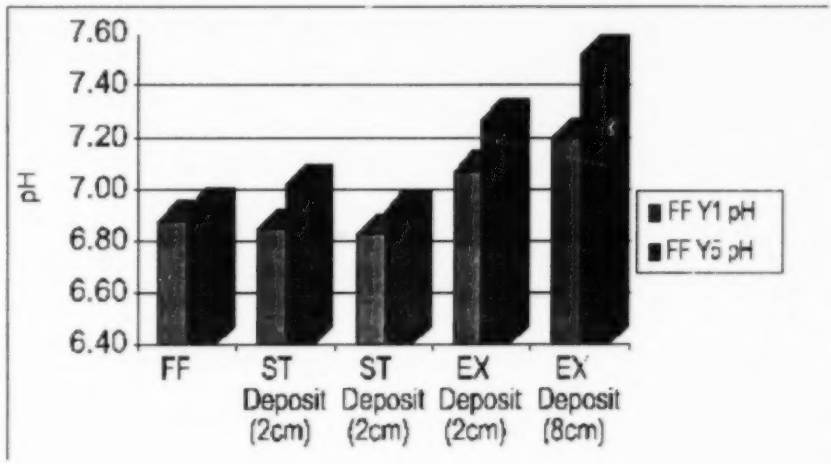

Figure 3. Comparison of forest floor pH after the different treatments.

deposits are changing the forest floor pH, but how they are affecting nutrient availability and thus potential site productivity.

Year One and Year Five post-harvest.

Figure 4 shows that phosphorus (P), boron (B), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), and cobalt (Co) are all sensitive to a pH range displayed by the calcareous deposits in this study. The mobility of some of these nutrients are directly affected by the pH while others, like P, form insoluble precipitates with the excess calcium and magnesium. At the pH ranges studied, some of these essential nutrients are considered to reach growth-limiting levels; tree mycorrhizae may help alleviate these problems, but possibly at a cost of extra photosynthate. For example, in a study of tree growth on rehabilitated skid roads, Dykstra and Curran (1999) found poorer tree growth on calcareous soil deposits. And, lab data currently under analysis demonstrates lower soil Fe and Zn, but this is not reflected in foliar Fe levels, presumably due to mycorrhizae.

Roots are often observed growing in high pH soils, but it is not known if these are simply there for physical support and water collection. However, more fine roots—those which are typically related to nutrient uptake—are most commonly found in the upper, more acidic soil horizons in these soils.

The pH of the mineral soils dropped slightly after being weathered (in this case leached); but, the results showed that mineral soils maintained a constant pH throughout the five cycles of the trial. It is therefore reasonable to believe that the mineral deposits will continue to maintain a high pH while altering the forest floor for an indefinite time. The rationale is that the forest floor and leachate pH were still increasing after five years of leaching, and soils in the Rocky Mountains take a long time to weather very deeply; approximately 10 000 years after glaciation, the depth to free lime is often less than 20 cm (12 cm in the case of the one site studied by Dykstra and Curran 1999).

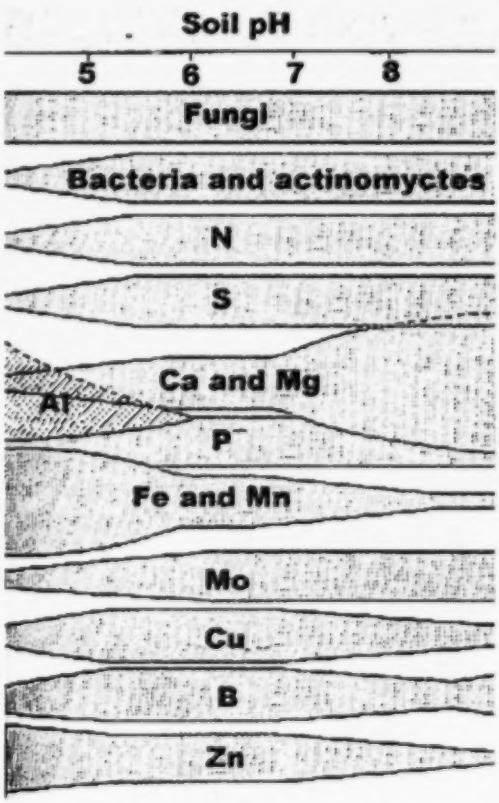

Figure 4. General relationships existing in mineral soils between pH and the availability of nutrients. A greater band width means nutrients are more readily available at that pH (from Brady and Weil 1996).

RECOMMENDATIONS

The subsoils at the Whitetail Brook study site contain up to 40% free lime, and are a fair representation of the strongly calcareous soils found overall in the Invermere, Cranbrook, and parts of the Columbia Forest Districts. On these soils excessive disturbance must be avoided during harvesting or site preparation, and should probably rule out root removal as a means of treating Armillaria root rot; this recommendation has already been included in the *Armillaria Root Disease Management Guidelines for the Nelson Forest Region* (Norris et al 1998).

Lighter disturbance associated with careful planning or mechanical site preparation may still be

acceptable, provided exposure of underlying calcareous soils is minimal.

Research on the use of an alternative, competing fungus for Armillaria control on these soils has also been started at Whitetail Brook and on other calcareous soils in the local area, in cooperation with Dr. Bill Chapman, Research Soil Scientist, Cariboo Forest Region.

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For further information, contact:

Mike Curran, PhD, PAg — Research Soil Scientist, Nelson Forest Region, Ministry of Forests — **Phone:** (250) 354-6274 — **email:** Mike.Curran@gems5.gov.bc.ca